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Review of the *Glyptapanteles* species (Hymenoptera: Braconidae, Microgastrinae) Attacking Noctuids in Field Crops in the Neotropical Region, with Descriptions of Two New Species from the Ecuadorian Andes

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Abstract.—The six species of *Glyptapanteles* Ashmead known to attack noctuid pests in the New World are reviewed, with illustrated identification keys and discussions of their species status and possible relationships. Four of the species have been previously described: *G. bourquini* (Blanchard), **new combination**, *G. herbertii* (Ashmead), *G. militaris* (Walsh) and *G. muesebecki* (Blanchard), **new combination**. Two are newly described here: ***G. ecuadorius* Whitfield** and ***G. agrotivorus* Whitfield**.

Microgastrine braconid wasps are among the principal natural enemies of noctuid and other lepidopteran pests throughout the world (Whitfield, 1997). A large percentage of the microgastrine Braconidae attacking noctuids, especially in the temperate zones, belong to the genus *Cotesia* Cameron, probably one of the two largest genera of this subfamily with perhaps as many as 1,500 species worldwide (Mason, 1981). In the Neotropics, this dominant position of *Cotesia* is to some extent displaced by species in the genus *Glyptapanteles* Ashmead. This latter genus has never been revised in the neotropical region, so that identification of species, even those reared from agriculturally important pest species, can be difficult or impossible without repeated visits to museums with important reference material.

In this paper we review those New World species of *Glyptapanteles* known to have been reared from agricultural pests in the family Noctuidae. We have not attempted to cover all species that might be reared from noctuids outside field crop situations. The species treated here are a mix of principally Nearctic species with ranges extending into the Caribbean region (and occasionally into South America due to introductions), and of essentially South American species which also, in some lowland species, have ranges extending north through the Caribbean into the southern U. S., especially Florida. In reviewing these species, we describe two new ones encountered in the course of studies on natural enemies of noctuid pests in corn and vegetable fields in the central highlands of Ecuador.

MATERIALS AND METHODS

Larvae of several species of Noctuidae were collected by random sampling throughout the corn growing seasons (October to May) on small fields in Ecuador between 2,000 and 3,250 m elevation. In addition, collections were also made on a 7 ha experimental organic farm near Riobamba (2, 750 m el.), where vegetables are grown year round. Larvae of Lepidoptera were then identified using the key from Angula and Weigert (1975) and our own drawings. They were reared in plastic cag-

es (5 cm diameter × 1.5 cm height) with their natal host plants. When parasitoids emerged from the larvae, they were left in the cages until adults eclosed, which were then pinned.

Our Ecuadorian parasitoid material was then compared with holotypes and other determined material from the senior author's collection as well as from several major museums (see descriptions and Acknowledgments for details), as well as to the original descriptions of the New World *Glyptapanteles* species known to attack noctuids. Wings were removed from adult females, mounted between two glass slides, and projected using a microprojector for tracing and shading. Metasomata were removed from some females, separated into anterior and posterior halves using minuten needles and mounted in Euparal so that the anterior halves were visible in dorsal view and the posterior halves were visible in lateral view. These were then drawn using ocular grids in a Zeiss DRC microscope at 63×, and squared paper. In a few cases the metasomal features were drawn directly from point-mounted material. Cocoons were photographed using a Sony MVC FD90 digital camera with close-up lenses; natural lighting was supplemented with fibre optic lighting.

Morphological terminology follows that used in Sharkey and Wharton (1997) and Whitfield (1997). The descriptions presented below are to be attributed to the senior author.

KEY TO *GLYPTAPANTELES* FROM AGRICULTURAL NOCTUIDS IN THE NEOTROPICAL REGION

Note: Species of the microgastrine genera *Cotesia* and *Microplitis* are also commonly reared from noctuids. Specimens can first be identified to genus using Whitfield (1997). Readers may also wish to check the generic diagnosis of *Glyptapanteles* by Mason (1981). Care should be taken, when using the following key, that good soft (dispersed) lighting (such as with a ring light or through frosted glass or mylar) is available. In this way the fine sculpturing features on the first metasomal tergite in some species is visible, as is the true outline of the second tergite. These features can be difficult to discern accurately with harsh lighting since many of the specimens are so shiny. Slide mounting of metasomata can also be useful for discerning the finer features.

1. Junction of r and 2Rs in fore wing marked by a small knob, with r much longer than 2Rs (Fig. 1); first metasomal tergite somewhat sculptured and rounded posteriorly, second tergite often not well demarcated from third medioapically (Fig. 2); cocoon mass typically tightly spun together, occasionally looser, cocoons woolly, tan to orangish or pinkish in color (Fig. 19) ..... *G. bourquini* **(Blanchard)**
– Junction of r and 2Rs in fore wing not marked by small knob, rounded to obtusely angled and with r and 2Rs fairly equal in length (Figs. 4, 7, 10, 13, 16); first metasomal tergite usually more evenly narrowing from base to apex, second tergite always well demarcated from third medially by narrow suture (Figs. 5, 8, 11, 14, 17); Cocoon masses variable (Figs. 20–24), but usually not tightly spun together in a mass (except in *G. herbertii*, where it is elongate with cocoons arranged like stacked wood—Fig. 22) 2
2. First metasomal tergite with some distinct, but often very fine, punctation in apical half (Fig. 5), not highly polished apically; cocoon mass tan in color, elongate and with cocoons arraneged and stacked in parallel as with stacked wood (Fig. 22) .. *G. herbertii* **(Ashmead)**
– First metasomal tergite smooth and relatively polished throughout (Figs. 8, 11, 14, 17); cocoons variable, but typically not spun in an organized cluster although sometimes kept together by loose woolly threads (Figs. 20, 21, 23) 3
3. Hind coxa predominantly, typically entirely, bright yellowish in color, as is tegula; cocoons loosely spun together and white to light buff in color (Fig. 20) ..... *G. militaris* **(Walsh)**
– Hind coxa mostly dark brown to blackish, at least basally; tegula and cocoons variable .. 4
4. Second metasomal tergite about twice as broad posteriorly as long medially (Fig. 14), often with central part raised slightly, so that it may superficially appear less broad ..... *G. ecuadorius* **Whitfield, n. sp.**

– Second tergite much less than 2× as broad posteriorly as long medially, usually about 1.4X as broad or less (Figs. 11, 17) 5

5. First metasomal tergite at least 1.5× as long as anteriorly broad, and evenly narrowing posteriorly, with relatively straight lateral margins (Fig. 11); tegula pale yellowish brown; cocoons yellowish brown, spun in a loose mass (Fig. 21) ..... ***G. muesebecki* (Blanchard)**

– First metasomal tergite shorter, with more curved (convex) lateral margins rounding to apex (Fig. 17); tegula dark brown; cocoons white, loosely spun in a cluster with much loose silk (Fig. 23) ..... ***G. agrotivorus* Whitfield, n. sp.**

SPECIES NOTES AND DESCRIPTIONS

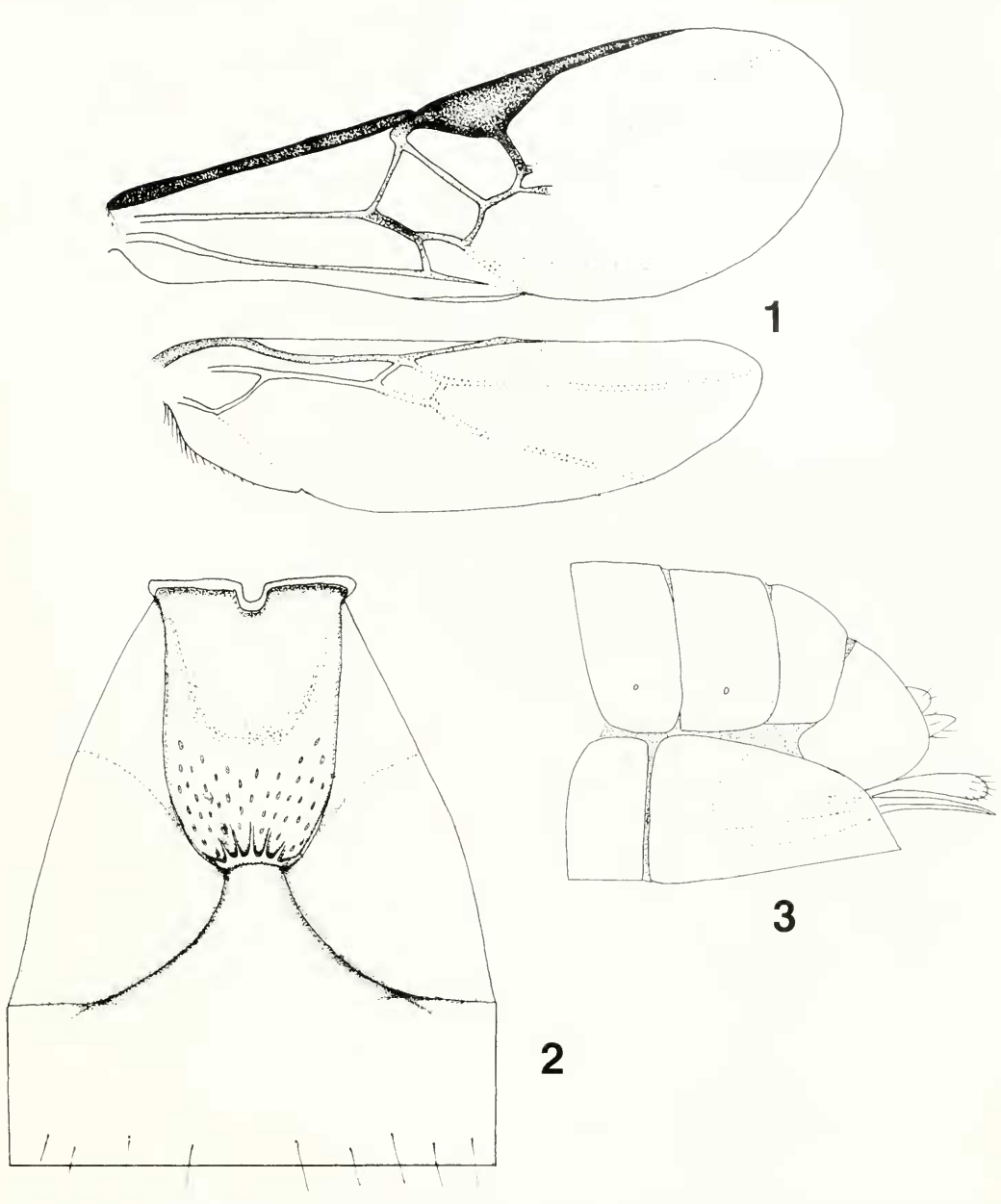
Glyptapanteles bourquini (Blanchard)
(Figs. 1–3, 19, 24)

Apanteles bourquini Blanchard: 137. Type, Blanchard collection, Buenos Aires, examined. Portions of Blanchard's material and other reared material also examined in United States National Museum, Washington (USNM).

Apanteles elegans Blanchard 1936: 139. Type, Blanchard collection, Buenos Aires, examined. This and other material referred to as *elegans* appear to be conspecific with *G. bourquini*. **New synonymy**.

Blanchard (1936) described *bourquini* and *elegans* in consecutive pages of his treatment of Argentinian microgastrines. According to his descriptions, the distinguishing features of the two are slightly shorter distal antennomeres in *bourquini*, slightly shorter fore wing 1Rs in *elegans*, and the color of the cocoon masses of the two species, those of *bourquini* being a more brownish white, while *elegans* spins masses of a more orange-brown color. In the material we have seen, cocoon color varies between these extremes, and the antennomere length difference does not appear to hold up. The latter is also sexually dimorphic in each species, so that it is possible that Blanchard actually described a male antenna for *elegans* and a female for *bourquini*. Most reared material appears to resemble Blanchard's wing figure for *bourquini* (see Fig. 1), with some tendencies towards the *elegans* configuration for 1Rs. Finally, both species are stated in the description to have been reared from *Psoragrotis* (*gypaetina* Gn. in the case of *bourquini*, and an undetermined species in the case of *elegans*). Shenefelt (1972), summarizing available published host records, listed, in addition to these species, *Peridroma margaritosa* (Haw.), *Pseudaletia unipuncta* (Haw.) and *Agrotis ipsilon* (Hfn.) for *bourquini*, and the first two of these also for *elegans*. It seems most likely that only one species of *Glyptapanteles* (a) attacks this set of hosts, (b) looks like *bourquini*, and (c) spins the characteristic compact cocoon mass attributed to these two species. Obviously there is some variation in the cocoon mass color, from tan or slightly pinkish through more orange-brown shades. We thus treat *elegans* as a junior synonym of *bourquini*.

In our studies, *G. bourquini* was reared from: *Agrotis deprivata* on *Brassica oleracea*, *Medicago sativa*, *Vicia vollosa* and *Zea mays*; *Agrotis ipsilon* on *Brassica oleracea*, *Daucus carota*, *Lactuca sativa*, *Medicago sativa* and *Trifolium repens*; and *Peridroma saucia* on *Trifolium repens*, all at 2770 m elevation (San Antonio, Riobamba Province, Ecuador, June, F. Ponce, collector). It is clear that the conditions of rearing can influence the appearance of the resulting cocoon masses, as these vary from compact masses (Fig. 19) to loose piles or even individually spun woolly cocoons, depending on the available substrate. The senior author has also seen reared material of this species from various other unidentified cutworms, from *Pseudaletia unipuncta* (Haw.), as well as one unconfirmed record from *Helicoverpa zea* (Boddie).



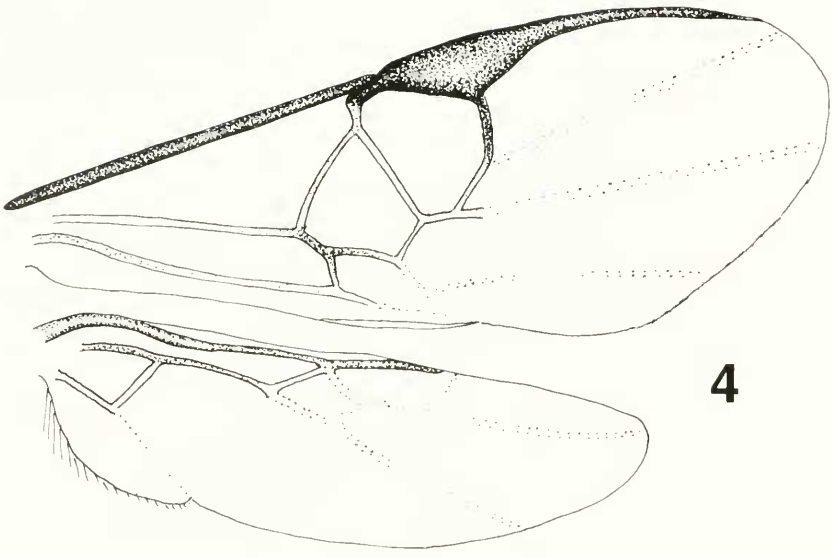
Figs. 1–3. *Glyptapanteles bourquini* (Blanchard), female. 1, Wings. 2, Anterior metasomal tergites, dorsal view. 3, Apex of metasoma, lateral view.

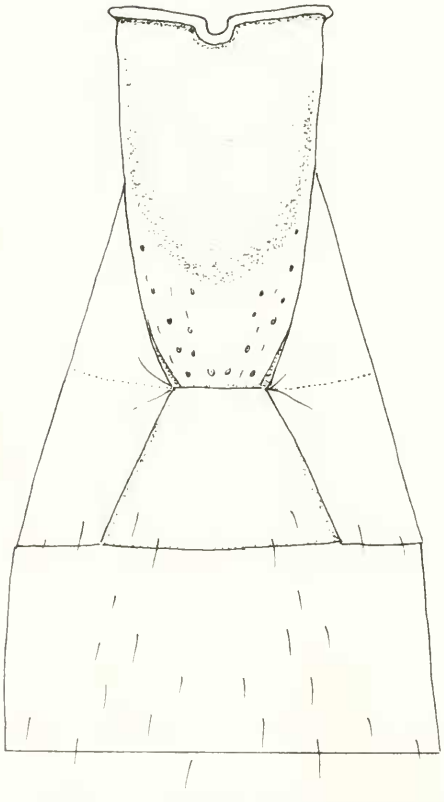
We are able to confirm geographical records from Argentina, Chile, Ecuador, and Uruguay. Probably it is found throughout the southern cone of South America and north into northern South America in the Andes.

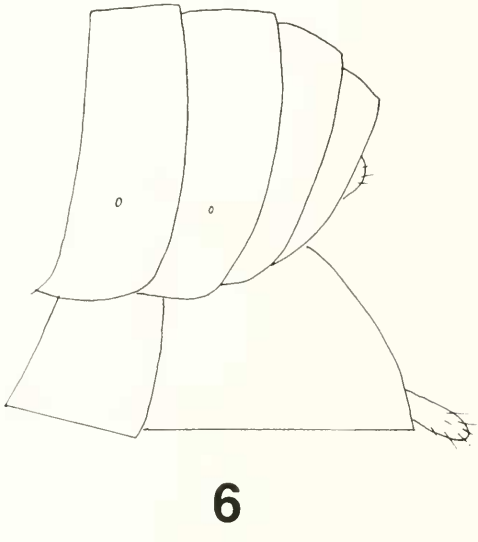
Glyptapanteles herbertii (Ashmead)

(Figs. 4–6, 22)

Apanteles herbertii Ashmead 1900: 279. Holotype, Natural History Museum (NHM), London, examined. Additional reared material from USNM examined.







Figs. 4–6. *Glyptapanteles herbertii* (Ashmead), female. 4, Wings. 5, Anterior metasomal tergites, dorsal view. 6, Apex of metasoma, lateral view.

This species apparently belongs to a difficult complex of species that includes *G. caffreyi* (Muesebeck), *G. militaris* (Walsh), and *G. muesebecki* (Blanchard), among others. Among these, it exhibits a relatively distinctive woodpile-arrangement cocoon mass (Fig.22); other *Glyptapanteles* spin similar masses, but not typically in agricultural habitats. It seems to have often been confused with *G. caffreyi*, at least based on the material determined as the latter species in the U. S. National Museum. All of the reared material we have seen, including specimens from the neotropics, determined as *G. caffreyi* appears to represent either *G. herbertii* or *G. muesebecki*. Presumably *caffreyi* also occurs south from Arizona into at least Mexico, but probably in western dry forest areas rather than the Caribbean habitats in which *herbertii* is often found.

The host listed for *herbertii* by Shenefelt (1972) and Marsh (1979) is *Hystalea nyseus* Cram. on guava From the material we have seen, the following appear to be more usual hosts: *Anticarsia gemmatalis* (see also Cave, 1995) and occasionally *Trichoplusia ni* and *Pseudoplusia includens* (although these latter are based on less confident identifications).

Geographically, the species appears typically circum-Caribbean, but is also found further south in South America. We have confirmed records from Argentina, Belize, Colombia, Cuba, Ecuador, Florida, Mexico, Nicaragua, Peru and Venezuela.

Glyptapanteles militaris (Walsh)
(Figs. 7–9, 20)

Microgaster militaris Walsh: 369. Unique holotype or lectotype not designated from original material, but at this point identity of the species has not been controversial. Examined on the basis of extensive material in USNM, Illinois Natural History Survey, as well as senior author's collection of reared material.

This species is abundant wherever corn (maize) or other gramineous crops are grown, at least in the Nearctic region, and is recorded from a variety of noctuids on grasses, including native grasses in wild areas. The principal host in agricultural settings, at least in North America, is the armyworm, *Pseudaletia unipuncta* (Haw.).

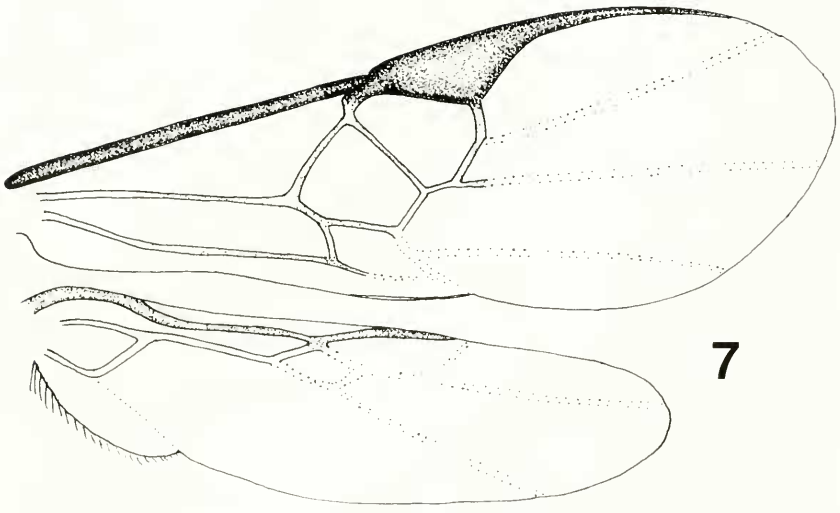
The cocoons of this species are reported to vary in color between white to buff, and are spun loosely on or near the host caterpillar's body (fig. 20). This variation means that this species may be difficult to unequivocally separate from *G. muesebecki* and one of the new species described below, based on the cocoons. It is possible that what we and previous workers have interpreted as species differences in fact only represent geographical and/or host-induced differences within a single species. For instance, the distinctive yellow hind coxa of *militaris* may prove to be geographically and environmentally variable outside North America. For now we are treating these entities separately, hoping that whatever individual biological differences they have will become clearer with additional records. Mason (1981) provides excellent SEM photos of some features of *G. militaris*.

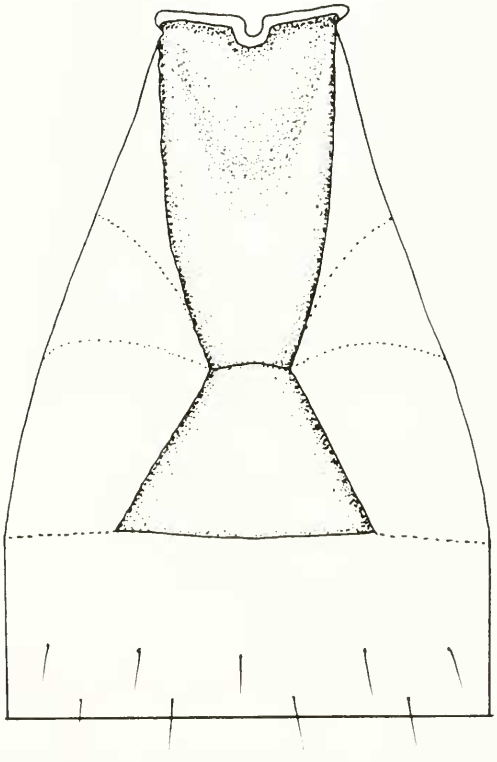
Glyptapanteles militaris is common throughout most of North America. In the neotropics it is frequently reported, although many of these records may in fact be misidentifications of the other species treated here. Probably it is at least found in the Caribbean region.

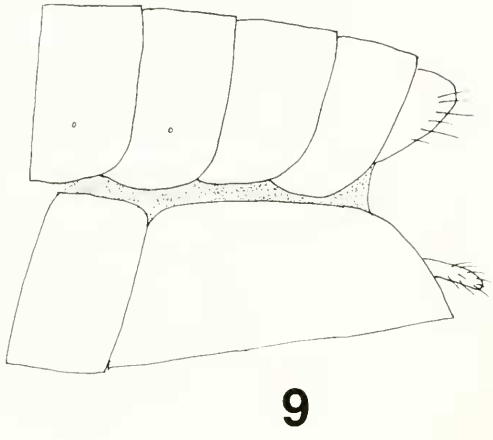
Glyptapanteles muesebecki (Blanchard)
(Figs. 10–12, 21)

Apanteles muesebecki Blanchard 1947: 18. Type in Blanchard collection, Buneos Aires, examined along with associated reared material now in USNM.

This species was originally referred to as *militaris* by Blanchard, (1936), then, upon receiving material determined as *militaris* by Muesebeck some years later, he decided that his South American material in fact represented a distinct species and described *muesebecki* (Blanchard 1947). The distinctions made then between the species were very fine, as they still are

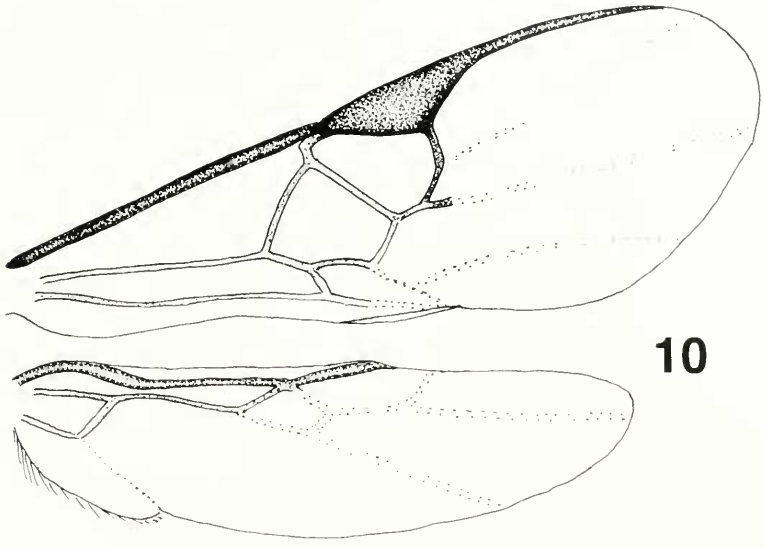


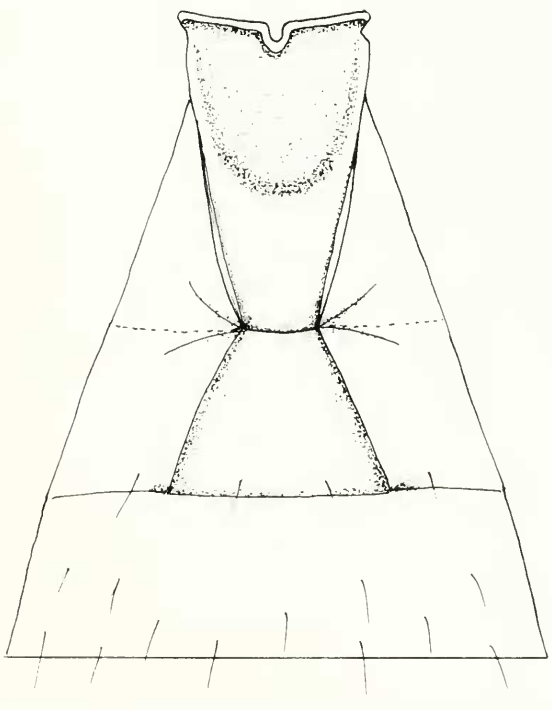


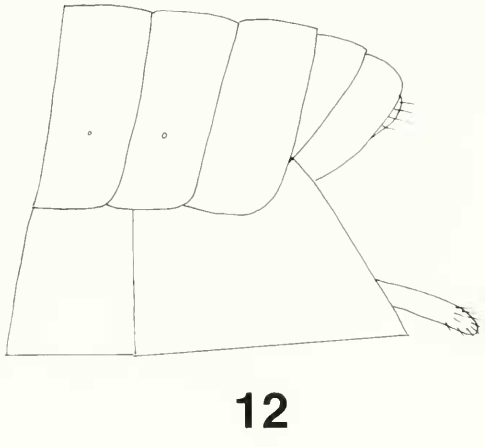


Figs. 7–9. *Glyptapanteles militaris* (Walsh), female. 7, Wings. 8, Anterior metasomal tergites, dorsal view. 9, Apex of metasoma, lateral view.

here, and the distinct species status of the two species really needs to be examined using extensive geographical sampling and genetic data. Since the examined cocoon masses of *muesebecki* are considerably more orange-brown (Fig. 21) than those we have from Nearctic *militaris* (Fig. 20; some cocoon masses are more dirty whitish, even tan, than those in this photo), and there are some very slight mor-







Figs. 10–12. *Glyptapanteles muesebecki* (Blanchard), female. 10, Wings. 11, Anterior metasomal tergites, dorsal view. 12, Apex of metasoma, lateral view.

phological features, mentioned in the key above, to support a distinction, we have treated *muesebecki* provisionally as a distinct species. Blanchard (1947) mentioned the narrower first and second metasomal tergites and dark hind coxa of *muesebecki* as being distinctive; we have found the former feature to be better described as:

muesebecki tending to having more straight posteriorly narrowing margins of the first tergite, and tergite 2 being narrower *posteriorly* than in *militaris*.

To confuse matters, *G. muesebecki* is recorded from *Pseudaletia unipuncta* (Haw.), the same principal host as *G. militaris*. We have not really seen many geographical intermediates between the two, *G. militaris* being common in North America and the Caribbean region, while *G. muesebecki* is only recorded from Argentina and Paraguay.

Glyptapanteles ecuadorius Whitfield, new species

(Figs. 13–15)

Female.—Body length 2.5–2.7 mm. Fore wing length 2.5–2.7 mm. *Color*. General body color black, except: lighter brown/yellowish palpi, front, middle and hind legs (except dark brown hind coxal base and apical portions of hind femur and tibia). Wings (Fig. 14) hyaline, veins including stigma generally pigmented very dark brown in pigmented portions. *Head*. Face shallowly punctate but still rather shiny, broad with inner margins of eyes not converging towards clypeus. Antenna slender, black, slightly longer than entire body length. *Mesosoma*. Mesoscutum shallowly, weakly but distinctly punctate throughout. Scutellum sculptured as mesoscutum. Metanotum with broad, nearly smooth and hairless lateral setiferous lobe. Propodeum coarsely rugulose over much of surface; nucha surrounded by very short radiating carinulae that occasionally appear to suggest posterior arms of an areola or a medial carina. *Metasoma*. Tergite I (fig. 14) smooth, relatively polished throughout, with medial depression over anterior 0.3–0.4; approximately twice as broad anteriorly as posteriorly and about 1.5× as long as broad anteriorly; lateral margins converging towards apex in a gentle curve; laterotergites light dorsally; tergite II about 2× as broad apically as long medially, but often appearing narrower in poor lighting when more strongly raised central portion is more obvious; laterotergites much darker than those of tergite I. Hypopygium (Fig. 15) evenly sclerotized, about 3× as long medially as previous sternite; apex curving to about 70° angle at tip. Ovipositor sheath short, more slender basally than is typical in *Glyptapanteles*, slightly paddle-shaped (more strongly convex ventrally), hairy only at tip. *Legs*. Hind coxa dark brown over basal half, then becoming orangish distally. Hind tibial spurs shorter than half length of basitarsus, with inner spur slightly longer. *Wings*. Tegula dark brown. Fore wing (Fig. 13) R1 extending about 4 times as far beyond stigma as distance from its distal tip to end of 3RS fold. Stigma evenly dark brown. Veins r and 2Rs approximately of equal length, or r very slightly longer, meeting in obtuse but distinct angle.

Male.—Similar to female except distal antennal segments longer and more slender.

Cocoons.—We have not examined cocoons of this species.

Hosts.—*Helicoverpa zea* (Boddie) on maize (*Zea mays* L.) is the only recorded host so far.

Material examined.—*Holotype female*: ECUADOR: Riobamba, Bilbao, 2000m elevation, XII-1998, F. Ponce, ex *Helicoverpa zea* on *Zea mays*. *Paratypes:* 1 male, 1 female, same data as holotype. Deposited in USNM and also (1 paratype) in the collection of Departamento de Zoologia Pontificia Universidad Católica del Ecuador, Quito.

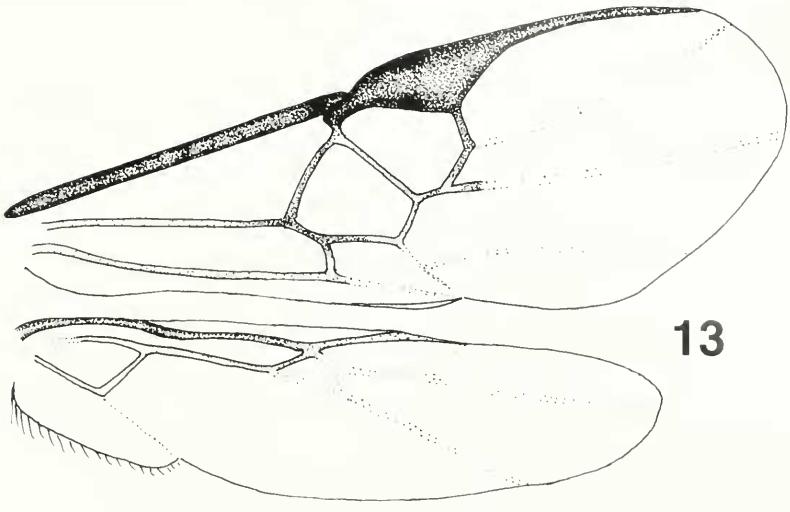
Etymology.—The specific epithet obviously refers to the only country (Ecuador) in which this species has been recorded so far.

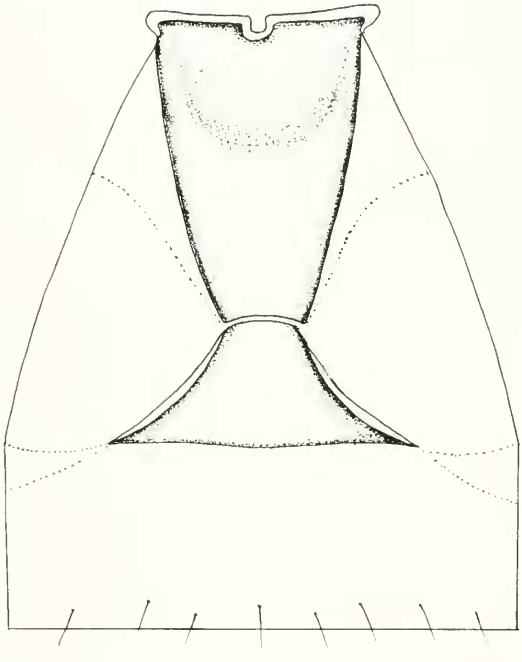
Comments.—This species seems to be an Andean endemic. It shares with *G. bourquini* proximally slender, paddle-shaped ovipositor sheaths, and dark tegulae, but otherwise seems to share more features with the *militaris* group of species.

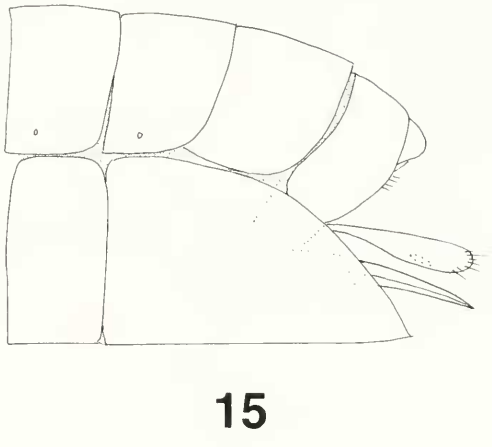
Glyptapanteles agrotivorus Whitfield, new species

(Figs. 16–18, 23)

Female.—Body length 2.1–2.3 mm. Fore wing length 2.2–2.4 mm. *Color*. General

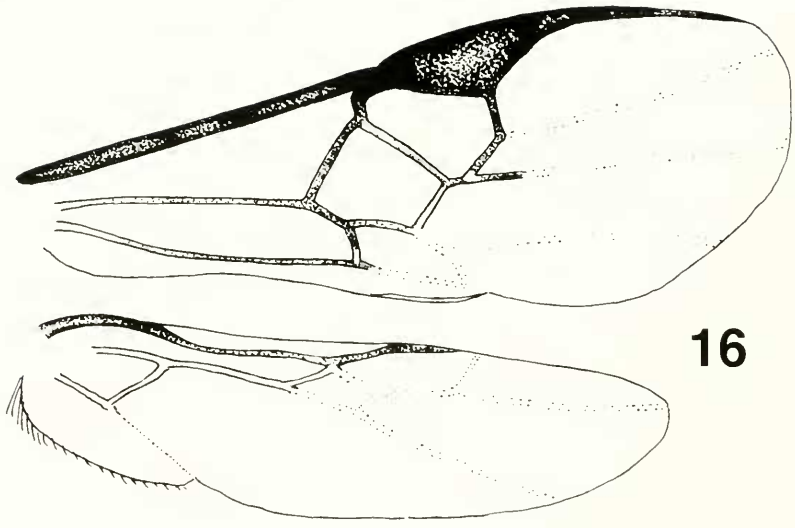


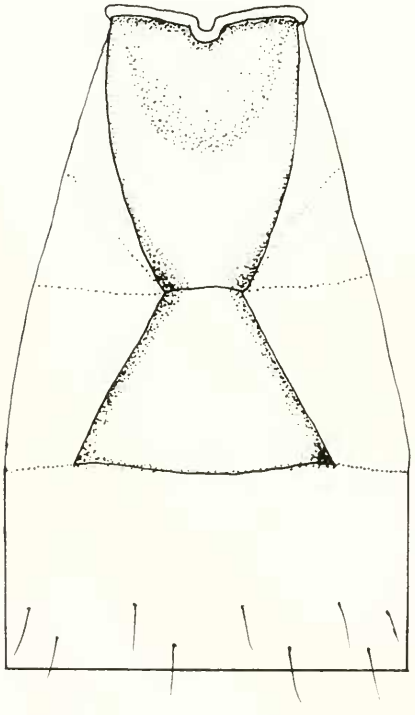


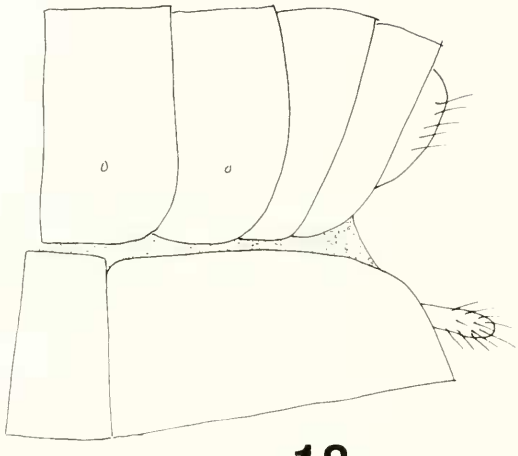


Figs. 13–15. *Glyptapanteles ecuadorius* Whitfield, n. sp., female. 13, Wings. 14, Anterior metasomal tergites, dorsal view. 15, Apex of metasoma, lateral view.

body color black, except lighter brown: fore and middle legs beyond coxae, proximal ⅔ of hind femora and tibiae. Wings (Fig. 16) hyaline, veins including stigma, when pigmented, generally pigmented dark brown. *Head.* Face coarsely but very shallowly punctate, slightly shiny, broad and as wide near clypeus as near antennal bases. Antenna black, slender, longer than body, even in fe-







Figs. 16–18. *Glyptapanteles agrotivorus* Whitfield, n. sp., female. 16, Wings. 17, Anterior metasomal tergites, dorsal view. 18, Apex of metasoma, lateral view.

male. *Mesosoma.* Mesoscutum finely and evenly punctate throughout. Scutellum evenly puncate, but more sparsely so than mesoscutum. Metanotum with broad, smooth and weakly hairy lateral setiferous lobe. Propodeum finely rugulopunctate throughout, more coarsely so medially, with no obvious carinae. *Me-*

Figs. 19–24. Cocoon masses and larvae of *Glyptapanteles* spp. 19, *G. bourquini*. 20, *G. militaris*. 21, *G. muesebecki*. 22, *G. herbertii*. 23, *G. agrotivorus*. 24, Larvae of *G. bourquini* emerging from host caterpillar.

tasoma. Tergite I (Fig. 17) essentially smooth and relatively polished throughout, with a medial depression over anterior 0.4; 1.3–1.5× as long as anteriorly broad and about twice as broad anteriorly as posteriorly, with evenly curved lateral margins (Fig. 17 shows a first tergite that is on the short end of the spectrum of available material). Tergite II about 1.3× as broad apically as medially long, entirely smooth and with posterior edge very slightly convex medially. La-

terotergites fairly dark brown, on II more so than I. Hypopygium (Fig. 18) about 3× as long medially as preceding sternite, curving to rather truncate (80°+) tip. Ovipositor sheath short, blunt, apically hairy, projecting only slightly beyond tip of hypopygium. *Legs.* Hind coxa very finely punctate, almost completely dark brown to black except lighter at extreme apex. Hind tibial spurs shorter than half length of basitarsus, inner spur slightly longer than outer. *Wings.* Tegula dark brown. Fore wing (Fig. 16) R1 extending about 3–4 times as far beyond stigma as distance from its distal tip to end of 3RS fold. Stigma evenly very dark brown, sometimes visibly paler centrally. Fore wing veins r and 2Rs about equal in length, or r slightly longer, meeting at a sharp but obtuse angle.

Male.—Similar to female except apical flagellomeres longer.

Cocoons (Fig. 23).—White, loosely spun together with coarse silk.

Hosts.—Agrotis ipsilon (Hfn.) on *Brassica oleracea.*

Material examined.—Holotype female: ECUADOR: Riobamba, San Antonio, 2770m elevation, 13-VII-2000, F. Ponce, ex *Agrotis ipsilon. Paratypes:* 1 male, 1 female, same data as holotype. Deposited in USNM and also (1 paratype) in the collection of Departamento de Zoologia Pontificia Universidad Católica del Ecuador, Quito.

Etymology.—The specific epithet refers to the fact that this species is known to attack ("eat") cutworms of the genus *Agrotis.*

Comments.—This species, both in the appearance of the cocoons (Fig. 23) and in general morphology, most closely resembles *G. militaris* (Walsh). It does appear to differ in the shorter first metasomal tergite, in having a dark hind coxa, and in attacking a different host. Until a comprehensive population-level study is completed of this complex of species, it seems best to treat this as a distinct species.

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LITERATURE CITED

Angulo, A. and G. Weigert. 1975. Noctuidae (Lepidoptera) de interés económico del valle de Ica, Perú,: clave para estados immaduros. *Revista Peruana de Entomologia* 18: 98–103.

Ashmead, W. H. 1900. Report upon the Aculeate Hymenoptera of the islands of St. Vincent and Grenada, with additions to the parasitic Hymenoptera and the a list of the described Hymenoptera of the West Indies. *Transactions of the Royal Entomological Society of London,* 1900: 207–367.

Blanchard, E. E. 1936. Microgastrinos argentinos, nuevos y poco conocidos. Segunda parte. *Physis, Revista de la Sociedad Argentina de Ciencias Naturales* 12 (43): 137–152.

Blanchard, E. E. 1947. Descripciones y anotaciones de microgastrinos Argentinos (Hymenoptera). *Arthropoda (Buenos Aires)* 1: 6–22.

Cave, R. D. 1995. *Manual para el Reconocimiento de Parasitoides de Plagas Agricolas en América Central.* Zamorano, Tegulcigalpa, Honduras. 202 pp.

Marsh, P. M. 1979. Family Braconidae. Pp. 144–295 in: Krombein, K.V., Hurd, P. D., Jr., Smith, D. R. & B.D. Burks, eds., *Catalog of Hymenoptera in America North of Mexico. Vol 1. Symphyta and Apocrita (Parasitica).* Smithsonian Institution Press, Washington, D.C.

Mason, W. R. M. 1981. The polyphyletic nature of *Apanteles* Foerster (Hymenoptera: Braconidae): a phylogeny and reclassification of Microgastrinae. *Memoirs of the Entomolgical Society of Canada* 115: 1–147.

Muesebeck, C. F. W. 1920. A revision of the North American species of the ichneumon-flies belonging to the genus *Apanteles. Proceedings of the United States National Museum* 58: 483–576.

Sharkey, M. J. and R. A. Wharton. 1997. Morphology and terminology. Chapter 2, pp. 19–37 in: Wharton, R. A., P. M. Marsh, and M. J. Sharkey, eds. *Identification Manual to the New World Genera of the Family Braconidae (Hymenoptera).* International

Society of Hymenopterists Special Publication 1. 439 pp.

Shenefelt, R. D. 1972. Braconidae 4, Microgasterinae, *Apanteles*. Pars 7, pp. 429–668 in: Vecht, J. van der and R. D. Shenefelt, eds., *Hymenopterorum Catalogus (Nova Editio)*. W. Junk, 's Gravenhage.

Whitfield, J. B. 1997. Subfamily Microgastrinae. Chapter 29, pp. 333–364 in: Wharton, R. A., P. M. Marsh, and M. J. Sharkey, eds. *Identification Manual to the New World Genera of the Family Braconidae (Hymenoptera)*. International Society of Hymenopterists Special Publication 1. 439 pp.